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THE WHALE SHARK

E. W. GUDGER

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ZOOLOGICA

SCIENTIFIC CONTRIBUTIONS OF THE NEW YORK ZOOLOGICAL SOCIETY

VOLUME I, NUMBER 19.

NATURAL HISTORY OF THE WHALE SHARK

RHINEODON TYPUS SMITH

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PUBLISHED BY THE SOCIETY
THE ZOOLOGICAL PARK, NEW YORK

March, 1915

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FIG. 118. *Rhinodon typicus.* PLATE 26 OF SMITH'S ILLUSTRATIONS OF SOUTH AFRICAN ZOOLOGY.
From Bean (1905).

NATURAL HISTORY OF THE WHALE SHARK *RHINEODON TYPUS* SMITH

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Narrative.

In June, 1912, while a guest of the Marine Biological Laboratory of the Carnegie Institution of Washington at Tortugas, Florida, one of the laboratory men whose home is at Miami brought me a copy of the *Miami Metropolis,* giving an account of the capture of some great fish near that city. Later papers gave other and fuller accounts, but as the descriptions of the animal were very defective, it was impossible to decide what it was. On the whole, however, since all descriptions said that it was enormous in size and marked with white spots, I finally concluded that it was probably an Orca, or Killer Whale.

Toward the close of the following month (July), in passing through Miami on my way north, I stopped off for a couple of days and had an opportunity to see the skin of this huge animal, and to talk with its captor, Captain Charles Thompson. At this time, I had no knowledge of the Whale Shark, save an indefinite recollection of a picture of one and certain statements as to its great size and its occurrence on the east coast of Africa found in *Holder's Zoology,* which I had studied as a boy. However, the shagreen-like skin and the strap-shaped gill-slits, plainly showed that it was a shark.

This skin, which was the most enormous thing of the kind that I had ever seen, was hung over a long, wooden support, in a house built to receive it on the bank of the Miami River. Despite the fact that the skin had been cut and torn by harpoons and bullets, and had suffered much at the hands of tl gang of men which Captain Thompson had help him skin the fish, it

was in fair condition and in the hands of a good taxidermist was capable of making a fine mount. Captain Thompson informed me that he was in communication with such a man, and that in the meantime he was preserving the skin from decomposition by drenching it several times a day with strong brine and by sprinkling it with formalin.

The general color of the skin was brownish with large pale, white spots, perhaps as large as a silver dollar. No longitudinal bars, such as will be described later, and no short transverse markings, were noticed. The spread of the tail fin was so great that a tall man could stand under the tip of the upper lobe. The mouth and jaws, which had been cut out with the skin, were very large, so large that a man could have gotten within them. The teeth, which were in a band about two inches wide in each jaw, were very minute, prickle-like, recalling forcibly the old-fashioned "wool cards." Captain Thompson emphasized the fact that "the fish had no bones," save the backbone, a number of segments of which he showed me. These were cartilaginous, about five inches in diameter, bi-concave in form, and were of a yellowish-brown color, apparently due to the oil contained in them.

During the fall and winter of 1912-1913, I was in somewhat infrequent communication with Captain Thompson, who very kindly agreed to give me the data about the capture of the fish, but he was so engrossed in getting the skin mounted for exhibition for the winter tourists that he did not find time to do so. The mounting of this skin was a Herculean task, and was only done after some months' incessant labor.[1] This work was done by and under the direction of Mr. J. S. Warmbath, a professional taxidermist, of Washington City. The post-card figures of it, kindly sent me by Captain Thompson, with permission to publish, show that the work was well done.

On April 26, 1913, at the meeting of The North Carolina Academy of Science, I exhibited the photographs sent me by Captain Thompson and read a short paper on this fish as a preliminary report. This was published in *Science* for August 22. On May 3, Doctor Hugh M. Smith read a letter describing the

[1]It may be noted here that in preparing the skin nearly half a ton of shavings was removed from it.

capture and exhibited pictures of this shark at a meeting of the Biological Society of Washington. An abstract of his remarks appeared in a report of the meeting in *Science* for August 29.

In the *Bulletin* of the New York Zoological Society, for November, 1913, Doctor C. H. Townsend wrote very interestingly of this Whale Shark, and gave two figures, one of the mounted specimen and one of the fish taken shortly after its capture. The latter, showing a man crouching in the mouth cavity, gives an idea of its enormous size. It is reproduced herein as Figure 119.

Early in May, 1913, I was definitely informed of what had reached me through rumor previously, namely, that Captain Thompson had left Miami to exhibit his shark in the towns along the East Coast of Florida. On my reaching Tortugas toward the close of the month, our Miami men reported that he was understood to have the *Rhineodon* on exhibition in Atlantic City, and this was confirmed when I stopped in Miami, on July 29.

This was a great disappointment to me, for I had hoped to see and make careful descriptions and measurements of the mounted fish, and to get from Captain Thompson a full account of the capture of this rare animal.

However, I ascertained that, at the time of the capture of this shark, Captain Thompson's boat was chartered by Mr. Charles T. Brooks, of Cleveland, Ohio. After some difficulty, I succeeded in getting in communication with Mr. Brooks, and am indebteded to him for the following excellent and invaluable account of the capture. Mr. Brooks has put the matter so well that I cannot do better than quote him verbatim:

"I had engaged Captain Charles Thompson, of Miami, and his boat 'Samoa,' with Bob Denny as assistant, to go south along the coast from Miami for tarpon in the latter part of May, 1912. This was after the season had closed at Miami. There were just the three of us on this expedition. We finally anchored just below Knight's Key, about one-half mile inside from the old Florida East Coast dock. One morning the Captain saw the tail of a large shark, as he supposed, within a few feet of the viaduct. He asked me if I would like to see a shark harpooned, and I said that I would. He then began to be impressed with

the idea that this was the largest shark he had ever seen. We immediately took the launch and row-boat attached to it, and started to the fish which was then moving slowly along with its tail above water, parallel to the viaduct and only a few feet from it. The Captain shouted to a man on top of the viaduct, asking him if he had seen the shark. He replied that he had seen it, but that it was not a shark—and that he did not know what it was, and that it had been around there for three or four days. We approached closer, and finally the boat was right over the fish, and we could see his spotted back three or four feet below the surface. We were in this position when Captain Thompson threw the harpoon. The fish was harpooned at about half past nine in the morning. We called to our aid some fishermen who happened to be near with their boats, and with their help, succeeded after a while, by means of a sharp hook thrown over the fish's nose, in getting his body nearer the surface of the water, and from time to time, during the day, shot him in the back, perhaps forty or fifty times with a rifle. We tried shooting him with a shotgun with number 2 shot at a distance of perhaps two feet from his back, but the shot bounded off, leaving their impression in a circle of about an inch and one-half or two inches, for the depth of perhaps an eighth of an inch in his back.

"The fish circled several times in from the viaduct, perhaps half a mile, coming back again to the viaduct, and at one time when the tide was running rapidly out about one o'clock in the afternoon, we thought that he might go outside. The boats were carried by the tide outside the viaduct, but the fish remained inside and finally started further inside and made another circle.

"I was surprised that the fish did not put up any fight. He proved to be a sluggish monster, and seemed to fail to realize that anything particular was happening to him. He kept circling in his slow way, moving his tail, which was always above water, in an arc of about eight to ten feet, in a slow, regular fashion, drawing the several boats after him with great ease. There were several harpoons in him, and one line was fastened through his tail and another to the dorsal fin.

"About half past five o'clock at night, he made his last circle in from the viaduct, and was directed over toward a sand-bank

FIG. 119. *Rhineodon typus.* MIAMI, FLORIDA.
Showing size of mouth. After Townsend (1913).

FIG. 120. *Rhineodon typus.* MIAMI, FLORIDA.
Showing great size and length.

by poking his head with a boat hook; he finally stranded on the sand-bank, and several lines, one around his body, were made fast to oars and boat-hooks stuck deep in the sand of the bank. A piece was then cut out of his head and with a knife, attached to a pole, it was sought to reach his brain and kill him. We were surprised to find about three inches of gristle at this point in his head.

"I had his measure taken while in the water on the bank, and he measured thirty-eight feet. A 20-foot line put around his body for the purpose of anchoring him to the sand-bank, lapped over about two feet, so that we judged that he was about eighteen feet in circumference. His weight was pure estimate, but we though he would weigh something over five tons.

"Next morning, which was Saturday, we brought the 'Samoa' up alongside, and lashed the fish to the side and started for Miami. That evening we reached a point opposite Railroad Camp, and went ashore to telegraph for a tug, and some of the railroad boys were very much interested in the catch. They thereupon, the next morning, which was Sunday, came out on a railroad tug, perhaps a dozen of them, and one of them took the pictures which are enclosed. We started on our journey to Miami and on Sunday afternoon were met by the tug and finally reached Miami about four o'clock Monday morning.

"The color was rather a mouse color, covered with yellow spots two or three inches in diameter, which were generally located in parallel lines of yellow, running from the backbone down each side. This marking is to some extent shown by the photographs. Underneath the color was yellow. The Captain put him on exhibition at Miami on our arrival, and at the time I left, several days later, he was making an effort to preserve him, having engaged the services of a taxidermist at Miami. He was successful in his attempt, as I have seen photographs of the mounted fish, and have heard of him through friends who have been in Miami the past season."[1]

[1]Through the kindness of Mr. John Mills of Miami, Florida, my attention has been called to an article on the Whale Shark in the *Wide World Magazine* for November, 1914, entitled, "Captain Thompson's Catch." This was written by Victor Pitt-Kethley and is so obviously intended for a "thriller" and is so highly colored as to have no scientific value, and attention is called to it here only to say so.

Figure 119 shows the Whale Shark, which had been hauled up alongside the yacht. Of especial interest are the enormous mouth in which a grown man is crouching, the small nasal apertures—the left one being immediately over the man's head—and the small eye immediately posterior to the angle of the jaw. This is one of the figures given in Doctor Townsend's article. This picture, together with a number of others, was taken by Mr. Joseph N. Beck, who later sold the negatives to Mr. Brooks. Mr. Brooks has sent me copies of all these photographs and through his kindness, I am able to give this picture and the two following.

Figure 120 gives an idea of the great size of this Whale Shark, for the tip of the tail may be seen just under the bow of the launch in the background of the picture. Note also the great size of the dorsal fin, and likewise the short transverse bars on the sides of the back. However, these are much better shown in Figure 121, the last of the pictures sent me by Mr. Brooks. Attention is also called to the first and second dorsal fins, and the upper lobe of the caudal, all of which are spotted.

With no small difficulty, even when aided by a tug, the great shark was finally brought to Miami. Here it was put on a marine railway and hauled up out of the water, but its weight (estimated at 5 tons[1]) was so great that it broke the timbers of the railway. Figure 122 is from a post-card presented me by Captain Thompson, showing this huge creature after it had been hauled out of water. In the right lower jaw, the band of teeth is plainly visible, and the nasal orifices and flaps are well shown. The left eye is in perfect focus, as are the spots which on the head are more numerous but smaller.

Back of the eye, and only about one-half the distance of this from the angle of the mouth, as it appears in Figure 122, may be seen the comparatively small spiracle which is here about three times longer than wide. It can also be made out on Figures 120

[1]This estimate is Mr. Brooks's, while that of Captain Thompson is three times as great. However, there is possibly a better way to get at it and that is by the fisherman's ancient formula, which I copy from C. F. Holder. This is that the length in inches multiplied by the square of the girth in inches and the product divided by 800 will give the weight in pounds. Taking the length at 38 feet (456 inches), estimating the girth at 18 feet (216 inches), and performing the operations designated, we get 26,594 pounds, or 13¼ tons for the weight of this giant shark.

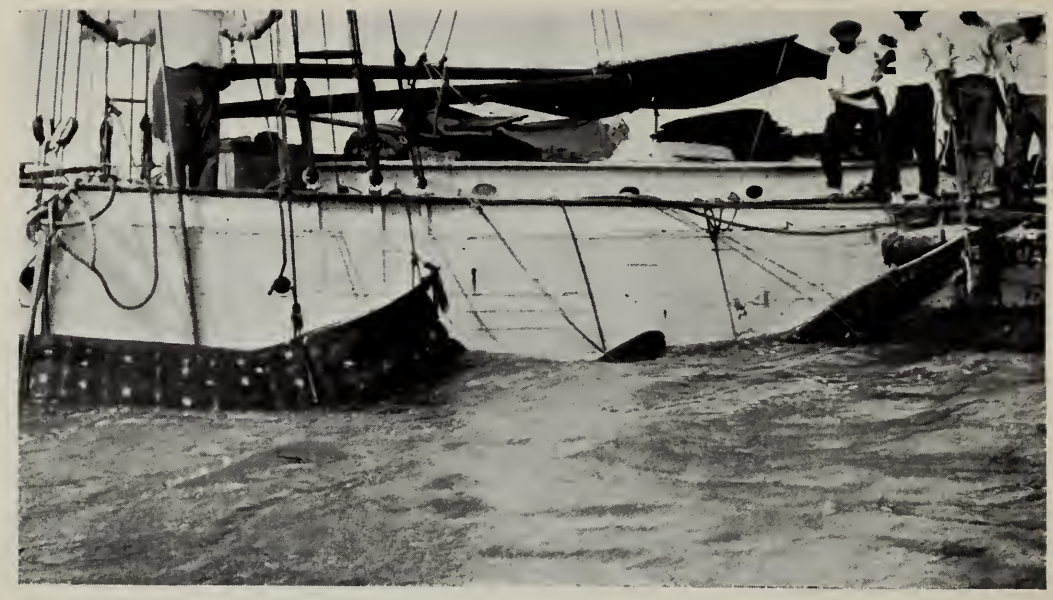

FIG. 121. *Rhineodon typus.* MIAMI, FLORIDA.
Showing dorsal fins together with spots and vertical bars.

FIG. 122. THE WHALE SHARK ON THE MARINE RAILWAY AT MIAMI.
To show mouth, teeth, nasal flaps, spiracle and gill-slits.

and 123. Back of the spiracle lie the enormous gill-slits which are also shown most plainly in Figure 122.

Figure 123 is made from a photograph of the mounted skin, and it shows how well Mr. Warmbath has done his work. Compared with Figures 120 and 121 made from photographs of the shark in the fresh condition, it would seem that the spots are too large. On the skin when seen by me in late July, 1912, the spots seemed about the size of a silver dollar, and were even then fading markedly.

It is a source of keen regret that I have not been able to examine this mounted specimen. A trip was contemplated to Atlantic City for this purpose, when it was learned that the specimen was in the Middle West. At last accounts it was on exhibition in Chicago.

Historical.

On a morning in April, 1828, some fishermen in Table Bay, Cape of Good Hope, South Africa, saw swimming leisurely around with its dorsal fin above water a large shark of unusual coloration. This was easily secured with the harpoon, since it offered comparatively little resistance, and was brought to shore where, fortunately for science, it fell in the hands of Dr. Andrew Smith, surgeon to the troops stationed in South Africa. Thus there came to the knowledge of the world the largest and in many ways the most interesting of the shark tribe.

During the following year (1829), Smith named his shark *Rhincodon typus* (evidently a misprint for *Rhineodon* as will be shown later), and gave a preliminary description of it as follows:

"Teeth slender, short, gently curved, so disposed in longitudinal rows that they have the form of a band in the front part of the maxilla and likewise in the similar part of the mandible; head wide, depressed, squarish, mouth at front of and almost as wide as the head; sides with longitudinal ridges and a very distinct keel on each side of the tail; a spiracle just behind each eye; anal fin almost opposite the second dorsal fin.

"Above, greenish-gray, with spots and numerous white lines; beneath, reddish-white, changing to red; with a dorsal keel before its anterior dorsal fin; behind, round, thence flat.

"Color of back and sides greenish-gray, with numerous white spots, varying in size from that of a sixpence to a half penny; also several white lines on the sides of the head, the body, and about the branchiæ; below, reddish-white, passing into vermillion red, anterior part of back carinated, posterior rounded or flat. Length of the specimen from which the description was taken, 15 feet; greatest circumference, 9 feet. Was caught by fishermen in Table Bay, during the month of April, 1828, and the skin was purchased for £6 sterling, and forwarded to the Paris Museum."

In 1841, Müller and Henle in their great "Systematische Beschreibung der Plagiostomen," an epoch-making work in the literature of the sharks and rays, give our fish a definite place under the name *Rhinodon typicus*. Their description is based on Smith's paper of 1829, and upon the dried skin in the Paris Museum. However, they give us one bit of information which Smith omitted, even from his second paper presently to be considered. They say: "The masculine appendages are in the single specimen small and do not extend backward past the hinder edges of the ventral fin."—i. e., this specimen was an immature male.

In 1849, Smith, in his "Illustrations of the Zoology of South Africa," published an elegant figure of our shark[1], which is reproduced herein as Figure 118 (frontispiece). He also redescribed the external features of the fish in the following words:

"Color.—The upper and lateral parts of the head and body dull lavender-purple, shaded with brownish-red; the under surface of the head, the sides of the body inferiorly, and the belly, light wood-brown, tinted with flesh-red, which tint is very strong on the anterior portion of the head and the hinder edges of the fin. On the upper and lateral parts of the head and body, and also on several of the fins, the ground-color is much broken by a profusion of small, circular white spots, and a great number of narrow vertical lines, which commence at the center of the back and terminate at the belly. The spots are smallest and most numerous on the head and upper surface of the pectoral fins, on the other parts they are larger and more scattered; and on

[1]The original figure in Smith's book has been colored by hand.

the caudal fin they are arranged in a single row close to its upper edge; the second dorsal, the anal, and the ventral fins are without spots. Eyes—coppery-red.

"Form, &c.—Head broad, depressed and somewhat wedge-shaped, the mouth opening directly in front; teeth small, recurved, closely congregated, and disposed in a broad, transverse belt along the inner surface of each jaw, immediately inside the lips; eyes lateral and situated almost directly behind the angles of the mouth; pupil transversely oval; temporal orifice about three-fourths of an inch in diameter. Vertical section of the body, in front of dorsal fin, somewhat triangular; and the back, between that fin and the middle of the hind head, slightly arched and strongly keeled; back, posterior to the dorsal fin, flat and depressed. Sides of body, irregular from two distinct longitudinal keels, which commence together a little in front of and considerably above the upper extremity of the first branchia, and recede a little from each other as they proceed backward. Of these, the lowermost pursues a waved direction, and at last is lost in, or coalesces with, the keel on each side of base of caudal fin; the upper again pursues a more direct course, becomes forked posteriorly, and both its branches terminate under and anterior to the second dorsal fin; the keel on each side of the tail very strong and thin at the outer edge. At the base of the upper lobe of the caudal fin, there is a transverse groove, to admit of the ready elevation of the fin, a power so necessary to direct the course of the fish in swimming. The first dorsal fin, posteriorly, is deeply emarginate, and the second dorsal fin has its inferio-posterior angle prolonged into a slender sharp point. Pectoral fins large, and their hinder edge, towards its base, with a distinct, large, triangular elongation. Ventral fins very small, and directly below the hinder portion of the first dorsal; anal fin also small, quadrangular, and with its superio-posterior angle prolonged into a point, its anterior angle directly under the hinder extremity of the base of the second dorsal. Caudal fin deeply forked, the upper portion larger and much longer than the lower. Branchiæ slightly waved, the first and second much the longest, and, together with the third, are in front of the base of the pectoral fins; the fourth and fifth are directly over it."

We next hear of our great shark in a letter sent from Dr. Buist in Bombay, to Colonel Sykes in London and published in Proceedings Zoological Society of London, 1850. Dr. Buist[1] in describing shark fishing at Kurrachee in Northwest India, west of the mouth of the Indus River, speaks of the capture of the "Great Basking Shark or Mhor," a giant shark "often 40, and sometimes 60 feet in length." Here the spots are not mentioned, but, as there is no record of *Selache maximus* being found in the Indian Ocean, we must conclude that *Rhineodon* is referred to. So think most of the writers on this fish.

Our next reference, however, is to a gigantic shark so well described that there can be no doubt as to its identity. Captain James Steuart in his "Notes on Ceylon," (1862), page 156, says: "Sharks of the ordinary description are frequently seen; and on two occasions my attention has been called to spotted ones of such monstrous size as to make the common ones at their sides appear like pilot-fish."[2]

The next describer of the Whale Shark is August Duméril (1865), who, however, had only the skin of the Table Bay specimen and Smith's descriptions to work upon. He gives a very clear and comprehensive description, but adds nothing to our knowledge save in the matter of teeth, which will be considered later.

In 1865, Doctor Theodore Gill described from the Gulf of California a spotted Whale Shark which, misled by Smith's description and Müller and Henle's erroneous figure of the teeth, he differentiated from the genus *Rhineodon,* while retaining it in the family *Rhineodontidæ,* under the name *Micristodus punctatus.* His statement (omitting the description of the teeth to be given later) is as follows:

"In the year 1858 the Smithsonian Institution received, from Captain Stone, the jaws and vertebræ of an enormous species of shark existing in the Gulf of California and known to the inhabitants of the neighboring regions as the 'Tiburon Ballenas,' or 'Whale Shark.' The specimen represented by the

[1]Doctor Buist's information came from a correspondent at Kurrachee.

[2]For a copy of this extract from Steuart I am indebted to the kindness of Mr. C. Tate Regan.

FIG. 123. MIAMI SPECIMEN AFTER MOUNTING.
After Townsend (1913).

FIG. 124. MADRAS MOUNTED SPECIMEN OF THE WHALE SHARK.
After Thurston (1894).

spoils was said to have been '20 feet long,' with a 'head, six feet wide,' 'pectorals, 3 feet long' and 'flukes, six feet between tips.' 'The back from the head to the first dorsal fin, brown, with reddish spots.' The head is represented as truncated in front.

"This type will be seen, therefore, to be very distinct, but is evidently related to the South African genus *Rhinodon,* and must be referred to the family of *Rhinodontidæ* with the name of *Micristodus punctatus.*"

Jordan and Evermann (1896) copy Gill without being able to add anything to our knowledge, since, when they wrote, no other specimen had been taken on the west coast of North America and so far as the present writer knows this statement holds good to the present time.

In 1902, Mr. B. A. Bean published in *Science* a note on the coming ashore at Ormond, Florida, of an 18-foot *Rhineodon,* and in this referred to Doctor Gill's *Micristodus.* A few weeks later Doctor Gill, in the same journal, after comparing the teeth of the Floridan and Californian specimens, declared them to be at least congeneric. To this conclusion Günther (1884) had already come.

We now come to E. Perceval Wright, a naturalist whose opportunities for the study of the Whale Shark have been greater than those of all scientists from Smith in 1829 to the present writer in 1913, all added together, and who has in comparison made less use of them than any one else. In justification of this severe criticism, let us see what opportunities he has had and what he has done with them. Writing from the Seychelles, a group of islands in the western Indian Ocean northeast of Madagascar, he says in 1870.

"It was between this island and the eastern coast of Mahé that I had the good fortune to meet with the 'Chagrin.' I had often heard stories of this monstrous fish; but at first I attached as little credit to them as I do to the stories told by Bishop Pontoppidan about the 'Kraken'; however, Mr. [Swinburne] Ward having measured one that somewhat exceeded 45 feet in length, I felt bound to believe this evidence, longing all the while to corroborate it by my own personal experience. This I was able to accomplish, and, thanks to Mr. Ward's exertions, and to the offer of a reward of twelve dollars for the first specimen suc-

cessfully harpooned and brought to shore, I was enabled to take photographs of two specimens, male and female, of this remarkable shark, and to preserve all the more important portions of each for a more careful examination in Dublin. This shark, which is—the north whale excepted—the largest of living animals, would appear to have a very limited geographical distribution, and, contrary to the general habits of the true shark, it is not a carnivorous but a herbivorous fish. I have seen specimens that I believed to have exceeded fifty feet in length, and many trustworthy men, accustomed to calculate the length of the sperm whale (one of the most important stations for this cetacean is off Ile Denis, one of the Seychelles Group) have told me of specimens measuring upwards of seventy feet in length; it is a quiet, harmless fish, with a mouth of immense width, furnished with small teeth; it now and then rubs itself against a large pirogue, and as a consequence upsetting it, but under such circumstances it never attacks or molests the men, and while it reigns as a monster among sharks, is not, despite its size, as formidable as the common dog-fish. A stray specimen, about seventeen feet long, was found many years ago floating near Capetown, and was named by Sir A. Smith, *Rhinodon typicus*, but it would appear that nothing more has until now been known about this fish."

In his *Catalogue of Fishes in the British Museum,* Volume VIII, (1870), Günther quotes all the preceding writers, especially Wright, who had presented part of a pair of jaws to the Museum, but adds no new data.

Much of Wright's data is repeated in a paper published in 1877, and in his book, *Animal Life,* published in 1879. Now it will be noticed that Wright says that these sharks were common at the Seychelles. He saw at least four of them, he photographed two, and dissected at least two, and sent parts to Dublin for further study; but he never published his photographs, and never described any of the external or internal structures of the fish. To make sure of these points, I addressed a letter to the Librarian of Trinity College, Dublin, asking about these preserved parts.

This letter was answered by Doctor Henry H. Dixon, Professor of Botany in Trinity College, who kindly writes that nei-

ther preserved material nor photographs of Wright's specimens are known at the College. Dr. Dixon notes that Wright apparently made a report at the 1869 meeting of the British Association under the title, *"Rhinodon typicus,* the largest known shark," but that this was never published. Further than this, neither he nor Mr. Alfred de Burgh, assistant librarian, working from the published bibliography of Wright's papers, have been able to find any further published data. It is a great loss to science that Wright made so little of his extraordinary opportunities.

In his "Introduction to the Study of Fishes" (1880), Günther gives a very general description of the Whale Shark based evidently on Smith's and Wright's papers. There is nothing in it to detain us, since the new bit of data refers to its food and will be considered later.

In the *Annals and Magazine of Natural History* for 1883, A. Haly, director of the Colombo Museum, records the capture of a *R. typus* near Colombo, Ceylon, in 1883. This was a female, 23 feet 9 inches long, and 13 feet in circumference, having a mouth 3 feet wide. Before drying had taken place, the lower jaw was flat underneath, grading without break into the abdomen, and projecting so far beyond the upper that its band of teeth was uncovered. Haly dissected this specimen hoping to find eggs or embryos but found her barren. Unfortunately he gives no description of the reproductive organs. His careful measurements will be given later.

In the following year, Haly (1884) in his report for 1883 as director of the museum, says that this fish was taken at Moratuwa on January 5, 1883, and that its weight was so great that even after the viscera had been removed, it was handled only with the greatest difficulty. It was too large to be taken into the museum after mounting, so it was necessary to convert the main hall of the museum into a taxidermist's room.

The next reported capture of the Whale Shark is in 1884 by Signor G. Chierchia, whose interesting account is quoted *in extenso* from *Nature.*

"While fishing for a big shark in the Gulf of Panama during the stay of our ship in Taboga Island, one day in February (1883), in a dead calm, we saw several great sharks some miles

from our anchorage. In a short time several boats with natives went to sea, accompanied by two of the Vettor Pisani's boats.

"Having wounded one of these animals in the lateral part of the belly, we held him with lines fixed to the spears; he then began to describe a very narrow curve, and irritated by the cries of the people that were in the boat ran off with moderate velocity. To the first boat which held the lines just mentioned other boats were fastened, and it was a rather strange emotion to feel ourselves towed by the monster for more than three hours with a velocity that proved to be two miles per hour. One of the boats was filled with water. At last the animal was tired by the great loss of blood and the boats assembled to pull in the line and tow the shark on shore.

"With much difficulty the nine boats towed the animal alongside the Vettor Pisani to have him hoisted on board, but it was impossible on account of his colossal dimensions, but, as it was high water, we went to a sand beach with the animal and we had him safely stranded at night.

"With much care were inspected the mouth, the nostrils, the ears and all the body, but no parasite was found. The eyes were taken out and prepared for histological study. The set of teeth was all covered by a membrane that surrounded internally the lips; the teeth are very little and almost in a rudimental state. The mouth, instead of opening in the inferior part of the head as in common sharks, was at the extremity of the head; the jaws having the same bend.

"Cutting the animal on one side of the backbone, we met (1) a compact layer of white fat 20 centimeters deep; (2) the cartilaginous ribs covered with blood vessels; (3) a stratum of flabby, stringy, white muscle, 60 centimeters high, apparently in adipose degeneracy; (4) the stomach.

"By each side of the backbone he had three chamferings or flutings, that were distinguished by inflected interstices. The color of the back was brown with yellow spots that became close and small toward the head, so as to be like marble spots. The length of the shark was 8.90m. from the mouth to the pinna caudalis extremity, the greatest circumference 6.50m., and 2.50m. the main diameter (the outline of the two projections is made for giving other dimensions).

"The natives call the species tintoreva, and the most aged of the village had only once before fished such an animal but smaller. While the animal was on board, we saw several *Remora* about a foot long drop from his mouth; it was proved that these fish lived fixed to the palate, and one of them was pulled off and kept in the zoological collection of the ship."

This description was sent by Chierchia to Günther who, in the same number of *Nature,* commented most interestingly on *Rhineodon.* In addition to the occurrences hitherto noted Günther says that in 1878 Professor W. Nation examined a specimen taken at Callao, Peru, and sent a portion of the dental plate to the British Museum. Being unable to run down this reference, I referred it to my friend, Mr. H. M. Lydenberg, Reference Librarian of the New York Public Library, who kindly informs me that Nation had his headquarters at Lima and that he was a corresponding member of the Zoological Society of London. However, in none of the publications of the Society about this time, nor in the Royal Society Catalogue is there reference to any paper on *Rhineodon* by Nation.[1]

In *Elements of Zoology,* by C. F. and J. B. Holder (1884) there is a very crude figure of the Spotted Whale Shark. In fact, it is mottled rather than spotted, is devoid of keels and cross-bars, and in general is so imperfect that it does not seem necessary to reproduce it here.[2] In the following year (1885) Doctor C. F. Holder published his interesting book, *Marvels of Animal Life,* in which he gives some data concerning our fish, mainly taken from Wright but in part descriptive of the Ceylon specimen—the latter data communicated to him by Colonel Nicolas Pike, who had visited Ceylon the previous year.

[1]Since writing the above, I have accidentally found (Jan. 2, 1915) that Nation published his account in the *South Pacific Times* issued at Callao on Jan. 24, 1878. This journal is not to be found in either the Library of Congress, the New York Public Library, or the Library of the British Museum, and as there is not time to get a transcript from Callao, it is impossible to give Nation's description here.

[2]By an interesting coincidence, while reading the third proof of this article, the original drawing of this figure has been received. For it I am indebted to the kindness of Dr. C. H. Townsend who found it in the library of the New York Aquarium. The published reproduction in Holder's book is the first figure I ever saw of the Whale Shark.

The figure in his book is, like the preceding, more or less the product of the fancy of the artist and calls for no reproduction.[1]

In his report of the Colombo Museum for 1889, Haly (1890) notes the capture at Negombo, Ceylon, earlier in that year, of an 18-foot specimen. The skin of this specimen was presented to the British Museum where it was mounted and is now on exhibition. It is presumably the skin elsewhere referred to as mounted by Gerrard.

In 1894, Edgar Thurston, of the Madras Government Museum, published the following interesting account of specimens from Ceylon and the east coast of India.

"While in Colombo I took the opportunity of examining the excellently preserved specimen of *Rhineodon typicus* in the Ceylon Government Museum for the sake of comparison with the specimen, 22 feet in length from the end of the snout to the extremity of the tail, which was cast on shore at Madras in February, 1889, when I was unfortunately far away from headquarters, so that the chance was missed of examining its stomach contents and internal anatomy. The telegram which reached me announcing the arrival of the monster ran as follows:— 'Whale on shore. Stupendous spectacle.' But, on the following day, I learnt, from the evidence of an expert, that the whale was a shark. As the following extract shows, but few specimens of this gigantic elasmobranch have been recorded."

The "extract" referred to gives a résumé of the work of Smith, Wright, and Haly, and notes that the latter succeeded in obtaining several specimens. One of these was the 1889 specimen which was presented to the British Museum. This, it is stated, has been mounted by Gerrard, and though only a small specimen 17 feet long, makes a striking object in this great museum. In a foot-note we read that in April, 1890, another small specimen 14½ feet long was taken off Bambalapitiya, Ceylon.

Who the author of the above "extract" is, I have been unable to ascertain. The figure of the Madras mounted specimen is

[1]In a personal letter to the present writer, Dr. Holder says that these figures are the work of artists employed by the publishers and for which he is in no wise responsible.

herein reproduced as Figure 124. The dimensions of this shark will be given in the section on size.

In his *New Natural History,* Vol. V (1901), Richard Lydekker, under the heading "Basking Shark, *Rhineodon typicus,*" gives some general data, and his figure on page 2903 is only a fair adaptation of Smith's figure (1849).

In the *Zoologischer Anzeiger,* 1901, Kamakichi Kishinouye of the Imperial Fisheries Bureau, Tokyo, Japan, gives a descrip-

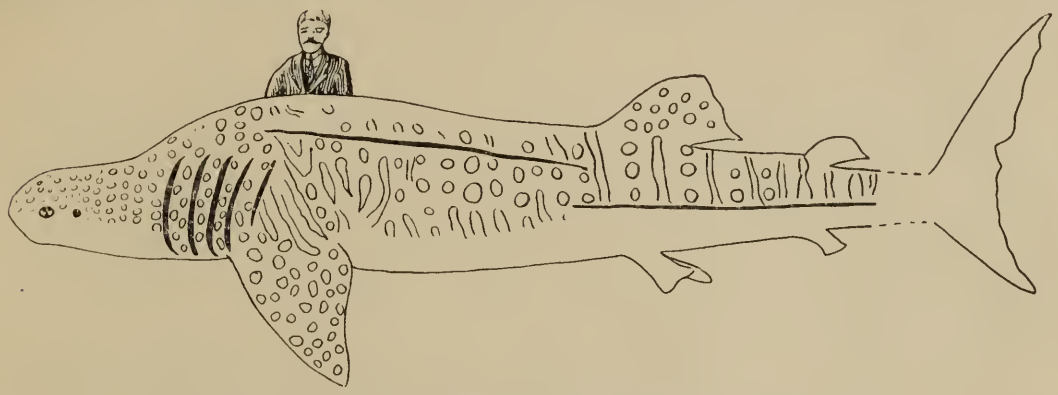

FIG. 125. LATERAL VIEW OF *R. pentalineatus* (Figure 118). After Kishinouye (1901).

tion of what he makes out to be a new species of *Rhineodon.* However, Doctor Gill (1902) thinks it *R. typus.* Omitting the description of the teeth (to be given later), the following is the interesting account of this fish given by the Japanese ich-

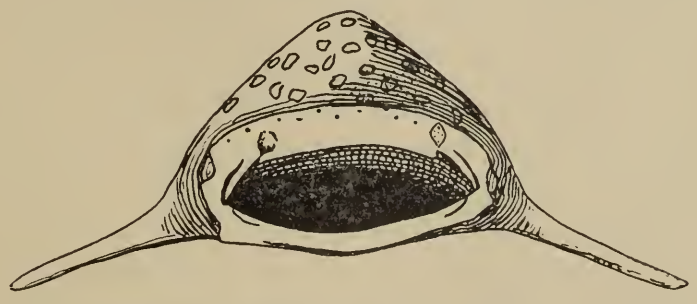

FIG. 126. FRONTAL VIEW OF *R. pentalineatus* (Figure 119). After Kishinouye (1901).

thyologist, while Figures 125 and 126 are lateral and frontal views copied from his paper:

"On 10th of June, 1901, a rare and gigantic shark was caught by drift net off Cape Inubo. Mr. Tsuratame Oseko who keeps

a collection of rare things for show in Asakusa Park, Tokyo, bought the fish and brought its skin to Tokyo to be stuffed, notwithstanding many difficulties accompanying its enormous size and ponderous weight. The external part is complete, except the portion between the anal fin and the caudal.

"The general appearance of the fish is very ugly, with the flat and blunt head, straight, terminal mouth and the small eyes. The skin is fine-grained, except five longitudinal smooth bands, one dorsal median and two pairs lateral. The ventral lateral band seems to be continuous to the keel on each side of the tail (Fig. 118).

"The eye is very small, situated at the sides of the head near the margin of the colored portion of the head. The nictitating membrane wanting. The spiracles are nearly the same in size and are on the same level with the eyes. The nostrils are at the anterior extremity of the head. They open at the labial boundary of the mouth.

"The mouth is nearly straight and opens at the anterior extremity of the head, too. A labial fold from the nostril to the corner of the mouth on the upper jaw and a shorter one from the corner of the mouth on the lower jaw. (Fig. 119.)

"The gill openings are five in number and are very wide. The second pair is widest and measures 86 cm. The last pair is most narrow, it opens above the base of the pectoral fins, where the body is very broad and high. The pectoral fins are large and long. The first dorsal fin is inserted a little behind the middle of the body. The second dorsal fin is very small. The ventral fins are inserted below the first dorsal. The clasper is simple, with a dorsal groove. The anal fin is very small. It is just below the second dorsal. The caudal fin is large and lunate. Its ventral lobe is well developed.

"The color is greyish-brown, with white round spots and transverse bands, but the ventral side is colorless. The white round spots are small and crowded near the anterior end of the body, but become gradually larger and fewer backwards. The caudal fin, the second dorsal, the ventrals and the anal, are destitute of white markings.

"The stuffed animal now measures 800 cm. in length and 365 cm. in circumference, behind the pectorals. Mr. Oseko tells me

that the skin has shrunk much and that the fish measured nearly 1000 cm. when fresh. He says, moreover, that the shark was covered with many sucking fishes and one of these fishes and a pole made of oak (ca. 30 cm. long) were found in the stomach.

"Though the hitherto-known allied species (*Rhineodon typicus* Smith and *Micristodus punctatus* Gill) are described insufficiently, I am inclined to believe that this fish is a new species of the *genus Rhinodon,* as it differs from these species in the form of teeth and the labial fold. Hence, I propose the name of *Rhinodon pentalineatus* for this species."

Jordan and Fowler (1903) list this shark in their "Elasmobranchiate Fishes of Japan" on the basis of Kishinouye's description.

On page 88 of his *Introduction et Description de l'Expedition* (Siboga), Max Weber (1902) records the fact that, while in the strait between Buton and Muna, Celebes Islands, East Indies, several examples of the Whale Shark were seen but none could be captured.

In his description of the fishes of this expedition (vol. 57 of *Siboga Expeditie,* p. 594), Weber says that these gigantic sharks swam around the vessel so closely that they were easily recognizable, but that, when an effort was made to capture them, they sank out of sight.

In *Science* for February 28, 1902, Mr. B. A. Bean, Assistant Curator of Fishes in the United States National Museum, records the stranding on the shore near Ormond, Florida, of an 18-foot specimen of *Rhineodon typus.* This is the first record of the occurrence of this rare shark on the eastern coast of America, and, in fact, its first known occurrence in the Atlantic Ocean. Its skin is now among the treasures preserved in the National Museum at Washington.

In the issue of *Science* for May 23, 1902, there appeared an exceedingly interesting article entitled "The Whale Shark (*Rhinodon typicus*) as an American Fish," from the facile pen of Dr. Theodore Gill. In this Dr. Gill gives a valuable résumé of a good portion of the known references to this rare fish, and concludes by conjecturing that the American forms may possibly be of a distinct species entitled *Rhineodon punctatus.*

Bridge (1904), in *The Cambridge Natural History,* Vol. VII, on page 454, gives a very general account of the *Rhinodontidae,* but adds practically nothing to our knowledge.

Again in *Science* under date of May 19, 1905, Dr. Gill summarizes some additional data bearing especially on the habits of the Whale Shark which he here calls *Rhineodon typus.* I take occasion here to acknowledge my indebtedness to these two articles of Dr. Gill and for data which he gave me personally.

A few weeks after the appearance of Dr. Gill's last note, Mr. Barton A. Bean published his valuable *History of the Whale Shark* in Smithsonian Miscellaneous Collections. This paper, giving a considerable number of verbatim quotations and being finely illustrated, has been of much help in the preparation of this article.[1]

In his paper Mr. Bean gives careful measurements of the Ormond, Florida, specimen, which will be reproduced later; he also gives a careful description of the teeth which will be referred to in the section on mouth and teeth. The skin of this 18-foot specimen was a dark brownish-grey, while the carinations were of a light chocolate color. The spots on the body were comparatively few, but large, while on the head they were smaller but in much greater numbers. The transverse light-colored bands were absent, strange to say, though probably they had faded out of the dried skin. Underneath the body was light colored. Fig. 127 is the elegant frontispiece to Mr. Bean's paper.

In the same year (1905) Jordan's *Guide to the Study of Fishes* appeared. On page 540 of Vol. I there is a paragraph given to the *Rhinodontidæ,* but there is no new data whatever.

In 1908, Lloyd records the capture of a small specimen at the mouth of the Hooghly River at the head of the Bay of Bengal in 26½ fathoms of water. This fish was 14 feet long, 4 feet wide across the nose and 3½ feet across the mouth. The girth around the head was 8½ feet, and around the belly 9½. Its color was a "dark bluish grey with large irregular paler blotches." The small teeth were in bands in each jaw, 350 rows of about 10 teeth to each row in a band, or about 7,000 in all.

[1]To the officials of the Smithsonian Institution I am deeply indebted, not merely for permission to copy the figures in Mr. Bean's paper, but for the use of the blocks themselves.

The occurrence of *Rhineodon* in the Java Sea is recorded by Van Kampen in 1908. On May 7 fishermen harpooned in Batavia Bay and brought to the fish market in Batavia a specimen 5.75 metres long (about nineteen feet). Van Kampen dissected this specimen but gives no account whatever of its internal organs.

Weber (1913) relates that Van Kampen showed him a beautiful photograph of a specimen which he thinks was probably caught in Madura Strait (north coast of Java) and photographed while fresh in the harbor of Surabaia. Unfortunately Van Kampen does not seem to have written up this specimen.

Dr. H. M. Smith in 1909, in an interesting paper entitled "Some Giant Fish of the Seas," gives only general data but a fine picture of the Whale Shark in the act of diving. Two years later before the Biological Society of Washington he made known the occurrence of this fish in the Philippine waters. His report, as it appears in the *Proceedings* (1911) will now be summarized.

In the issue of the *Philippine Free Press* of September 10, 1910, there is published a photograph with brief description of a marine monster from one of the islands, Negros Occidental by name. Throughout the article the animal is called a whale, but the photograph shows it to be a Whale Shark. It was about eighteen feet in length and was caught in a fish trap near Bacolod on September 4, 1910. This is the first capture, so far as known, that has been made in the waters of our western possessions.

Notices of the notes by the present writer (1913), Dr. Smith (1913) and Dr. Townsend (1913), on the Miami, Florida, specimen of 1912, have already been given in the first section of this paper, and need not be repeated here.

It seems that in *The Fishing Gazette* (London) early in May, 1913, there was published a reproduction of one of the postcard figures of the Miami specimen with a lot of nonsense about its being an unknown and unclassifiable monster. In the issue of that journal for May 24, Mr. C. Tate Regan of the British Museum replies in an interesting little article under the heading "The Largest Shark." In this he gives some brief quotations

from Wright and others, with a line drawing reproduction apparently of Thurston's figure of the Madras specimen.

The above called forth a letter from Mr. A. J. Boland in the next issue of the same journal in which he speaks of having seen in the Colombo Museum in 1903 a fine specimen of the great spotted shark. This he thought to have been from 30 to 35 feet long. "Around it were placed ordinary sharks, which looked like parr to salmon in comparison.[1]

Habitat.

This singular fish seems to be solitary in habit but of wide distribution. It was first reported from Table Bay, Cape of Good Hope, by Smith in 1829. Next Buist (1850) writes of a giant shark frequently captured at the head of the Arabian Sea at Kurrachee, west of the mouth of the Indus. Later Steuart (1862) reports it as not uncommon around Ceylon, as does Haly (1883, '84, '90), and Thurston (1894), while Shipley and Hornell record it in 1905.

Gill (1865) records a specimen taken in the Gulf of California about 1858. While Wright notes it as abundant at the Seychelles about 1869, as does Pike (1873) quoting from the notes of Swinburne Ward. Next we hear from Chierchia (1884) of its capture in Panama Bay, while in the same article Günther reports that Nation in 1878 had examined one at Callao. Next, omitting Thurston's Ceylon notes (1894) already referred to, but recalling the 22-foot specimen that he found ashore near Madras in 1889, we find this fish reported on the coast of Japan by Kishinouye in 1901. The following year (1902) Bean recorded its first occurrence in American waters and indeed in the Atlantic Ocean.

In 1902, Weber saw several in the Java Sea, while six years later Van Kampen recorded it in Batavia Bay, and in 1913 Weber refers to its capture on the north coast of Java. In 1908 Lloyd records its first known occurrence in the Bay Bengal. Its first appearance in the Philippines, so far as known, was noted by Smith in 1911. And its latest occurrence, and the second in

[1]For copies of the Gazette containing these articles, I am indebted to the courtesy of Dr. C. F. Holder.

our waters, is that of the Florida Keys specimen, for which data have been given in 1913, by Gudger, Smith and Townsend.

Through the kindness of Col. C. R. M. O'Brien, C. M. G., governor of the Seychelles, and of Mr. P. R. Dupont, Curator of the Botanical Station at Mahé, I have received information (December 8, 1914), that the "chagrin" is very common about the Seychelles throughout the year. Mr. Dupont writes that he has come across several himself, that the fishermen report that the smallest seen measures about 20 feet long, and that they come in shore when shoals of a Caranx make their appearance.

Thus we see that this huge but very rare fish, so far from having a restricted distribution, has an extraordinarily wide one. While found in the Atlantic, and not altogether infrequent in the Pacific, its especial habitat seems to be in the Indian Ocean and the waters contiguous thereto.

Size.

In size this fish varies greatly. Lloyd's specimen (the smallest ever taken) was 14 feet long and 9½ feet in girth. Smith's Table Bay specimen was 15 feet long and 9 feet around. Buist's figures make this shark 40 to 60 feet in length, the mouth being sometimes 4 feet wide. Steuart's sharks were of such enormous bulk that they made ordinary sized sharks look like pilot-fish. Gill's Gulf of California shark was 20 feet long. Wright dissected an 18-foot specimen. His friend, Swinburne Ward, measured one over 45 feet in length, while he himself saw specimens exceeding 50 feet, and "heard of some individuals—of about 70 feet in length." These latter were reported to him by the whale fishers of Saint Denis, "trustworthy men accustomed to calculate the length of the sperm whale."

Haly's 1883 specimen measured 23 feet 9 inches over all and 13 feet in girth behind the pectorals and had a mouth 3 feet wide, while that of 1890 was 5 feet shorter (18 feet). Chierchia in the Bay of Panama in 1884 "saw several great sharks some miles from our anchorage." The one captured was about 29 feet long over all and about 21 feet in circumference—an extraordinary girth for the length, the former generally being about one-half the latter. According to Thurston, the Madras specimen while fresh was 22 feet long, but the girth was not taken,

while a little one captured near Bambalapitiya, Ceylon, in 1880, was only 14 feet 6 inches in length. Kishinouye's specimen, named by him *R. pentalineatus,* when stuffed measured 26 feet in length and about 12 feet in circumference, but is reported to have been nearly 33 feet long when fresh. Bean's Florida specimen was 18 feet over all. Van Kampen's Batavia Bay fish was nearly 19 feet long, while the Philippine specimen recorded by Smith was slightly over 20 feet in length. The second Florida specimen was 38 feet long and as near as could be gotten about 18 feet in girth according to Mr. Brook's letter quoted above.

Fairly complete sets of measurements have been given for four fish as shown on the following page.

Color.

According to Smith, the discoverer of this fish, the color was above greenish-gray varying to dull lavender-purple and shaded with brownish-red; below reddish-white, becoming redder on edges of fins and under the head. The upper and lateral parts of the body were covered with white spots, smaller and more crowded on the head and adjacent parts, larger and more scattered behind, with narrow vertical white lines running from back to belly. See Figure 118.

Gill's specimen from the Gulf of California was brown with reddish spots above. Wright, notwithstanding his magnificent opportunities, has given us no description of the Seychelles form. Chierchia notes that his Panama Bay specimen was brown above with yellow spots so close and small on the head as to give it a marbled appearance.

Kishinouye found the Japanese fish to be grayish-brown above with round white spots and with vertical bars, while below it was colorless. As to size and number of spots he is in agreement with the other describers.

The first Florida specimen was a dark grayish-brown with large spots, while the keels were a light chocolate, but there were no vertical bars. These had probably faded out. For this fish see Mr. Bean's elegant Figure 127.

MEASUREMENTS OF THE WHALE SHARK.

Measurements of *Rhineodon typus*	Smith, Table Bay, 1829-1849		Haly, Ceylon, 1883		Thurston, Madras, 1894		Bean, Florida, 1905	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.
Length over all	16	6	23	9	22	0	18	0
Girth of body behind pectorals	9	3	13	0				
Girth of body one foot behind pectorals	8	5						
Distance from mouth to base first dorsal	8	6	10	0	9	10		
Distance from first to second dorsal	2	0	2	8	2	3		
Distance from second dorsal to root caudal fin	1	8						
Distance along upper lobe of caudal	4	0	5	0	5	0	3	6
Distance along lower lobe of caudal	2	10	2	7	2	6		
Distance along anterior edge first dorsal			1	10	1	10		
Distance along base of first dorsal			1	10	2	0	1	5
Height first dorsal	1	3						
Distance along anterior edge second dorsal		11		11½		11		
Distance along base of second dorsal		11		11½		7		
Length of pectoral fin	3	2	3	6	3	2	3	1
Breadth of pectoral fin along base	2	0			1	8	1	6½
Length of anal fin		9						10
Breadth of anal fin along base		9						6½
Length of ventral fin along anterior edge	1	0						10
Breadth of ventral fin along base	1	0						9½
Width of mouth	2	8	3	0	2	6		
Width between nostrils							1	9
Width of head one foot in front of first gill-slit	3	8½						
Diameter of eye				1½		1½		¾
Diameter of spiracle				1½		1x⅜		1½
Distance between eye and spiracle		4½				4		
Distance between tip of snout and eye		6				10		
Distance between tip of snout and first gill-slit	2	10			3	4		
Length of first gill-slit					1	11	1	6
Length of second gill-slit			2	7	1	11½	1	8
Length of third gill-slit					1	9	1	7
Length of fourth gill-slit					1	8	1	4
Length of fifth gill-slit					1	7	1	1

Of the second Florida specimen, Mr. Brooks says that while fresh: "The color was rather a mouse color, covered with yellow spots two or three inches in diameter, which were generally located in parallel lines of yellow, running from the backbone down each side. Underneath the color was yellow." In this connection see the various figures reproduced from the photographs loaned me by Mr. Brooks. These show the markings, especially in the region of the first dorsal fin, admirably.

After reading the above descriptions of the marked colors of these various specimens, one wonders why so eminent an ichthyologist as C. Tate Regan should say (1908): "As a rule the pelagic forms (. . . . *Rhinodon*). . . . have no conspicuous markings."

Jaws and Teeth.

The jaws are enormously large, the teeth almost microscopically small. Smith, the discoverer of the fish, says in his first paper (1829): "Teeth short, slender, gently curved, so disposed in longitudinal rows that they have the form of a band in the front part of the maxilla, and likewise in the similar part of the mandible."

Müller and Henle were the first scientists to examine Smith's specimen after its deposit in the Museum of Paris. Of it they say (1841): "Teeth extraordinarily small, conical, very numerous, card-like in arrangement. The conical teeth, with points somewhat curved backward, were in a 15½-foot specimen scarcely a line (1/12 inch) long. They stand in 12 to 15 rows one behind another, about 250 to a row." Their figure of

FIG. 128. TEETH OF *Rhinodon typicus*.
As represented by Muller and Henle.
After Bean (1905).

the teeth is given herein as number 128. This is from their plate 35 which also contains a semi-diagrammatic section of the tooth band. This contains fourteen rows, each having 19 teeth. Fourteen rows with 250 teeth to a row would give a total to each

FIG. 127. WASH DRAWING OF RHINODON STRANDED ON COAST OF FLORIDA.
Made from the skin and photographs by Mr. A. H. Baldwin. After Bean (1905).

jaw of 3500 teeth, if 15 rows, then 3750 teeth. Later it will be shown that both their description and their figure of the teeth are alike erroneous.

In his fuller paper (1849) Smith merely says: "teeth, small, recurved, closely congregated, and disposed in a broad, transverse belt along the inner surface of each jaw, immediately inside the lips." While of the Arabian Sea specimen Dr. Buist (1850) does nothing more than state that in the "Mhor" the mouth sometimes reaches a width of 4 feet.

In 1865 August Duméril after examining the Table Bay specimen gives as the characters of the family *Rhinodontidae*:

"Teeth exceedingly small and very numerous, analogous to the teeth of a card which are very fine and bent backward, and comparable to the brush-like teeth of certain teleosts, forming a band rough to the touch on each of the jaws on which the band is interrupted in the region of the median line."

While under the heading, *R. typicus,* he thus specifies:

"The band of teeth is formed by 12 or 15 transverse rows of teeth, having a width of about 0 m. 0 3. In a square of 0 m. 0 3. on each side are found 17 teeth in 12 rows each or 204 teeth. Now the two jaw bands form together, deduction being made for the median spaces, a length of one metre (.45 above, and .55 below), 33 squares of 0 m. 0 3. on each side, or 33 times 204 equals to at least 6732 teeth. This number is considerably larger than that given by Müller and Henle, who counted 12 to 15 rows of 250 teeth each, a number evidently too small, and who got only 3750 teeth" [in each jaw, a point Duméril overlooked].

Dr. Gill, in the same year (1865), in writing of the form from the Gulf of California, says:

"The dried dentigerous band of the upper jaw is slightly curved forward, about 19 inches between the extremities, and somewhat more than an inch in width in front. The teeth are fixed and extremely minute, the largest being little more than a line in length, and decrease toward the ends of the jaw; they are disposed in regularly transverse rows, of which there are over one hundred and sixty (164-167) on each side, while in front there are from thirteen to sixteen in each transverse

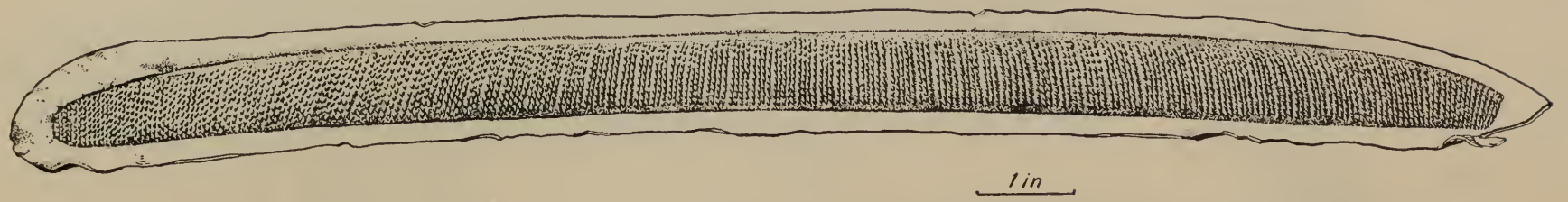

FIG. 130. DENTAL PLATE OF UPPER JAW OF ORMOND, FLORIDA, SPECIMEN.
After Bean (1905).

row; each tooth is recurved backwards and acutely pointed, swollen and with a heel-like projection in front rising from its base."

How accurate is Dr. Gill's description may be judged from the accompanying Figure 129 of the teeth of this specimen which is here copied from Mr. Bean's 1905 paper:

Wright speaks of the Seychelles "Chagrin" as having "a mouth of immense width, furnished with small teeth." Here it will be well to recall Buist's statement that the Kurrachee specimens had mouths 4 feet wide, while that of Haly's Ceylon fish was 3 feet across. Of the teeth, Haly writes (1883):

"When fresh, the lower jaw was quite straight and flat, nearly, if not quite, on a level with the surface of the abdomen, and considerably in advance of the upper, so that the band of teeth in the lower jaw was quite uncovered. This band averages one inch in breadth [in a 23-foot, 9-inch specimen], and consists of 14 rows of minute, sharp, recurved teeth, 2 mm. long, all of equal size. The band in the upper jaw is ¾ inch broad, and consists of 11 rows of similar teeth."

Chierchia merely says of the Panama specimen: "The set of teeth is all covered by a membrane that surrounded internally the lips; the teeth are very little and almost in a rudimentary state."

Nation sent a portion of the jaw of the Callao specimen to the British Museum. This was examined by Günther and the teeth compared with those of Ward's specimen from the Seychelles. Günther writes (1884): "The teeth differ in no respect from those of a Seychelles Chagrin; they are conical, sharply pointed, recurved, with the base of attachment swollen." This is the first detailed description of the teeth of *R. typus,* and so like Gill's account of the dental armature of *Micristodus punctatus* that Günther unhesitatingly declares them to be identical. (Here see Figure 129.)

Thurston says of the specimen in the Colombo Museum: "Each jaw is armed with a band of teeth arranged in regular transverse rows (14 in the lower jaw), and so minute that, in the present specimen their number has been calculated to be about 6,000."

Kishinouye thus described the dental apparatus of his specimen:

"The teeth are very minute and numerous. They are nearly equal in size and shape. Each tooth is acutely pointed, laterally compressed, and with an ellipsoidal root. The band of teeth on the upper jaw is curved a little and at each end of the band there is a detached group of teeth. The band on the lower jaw is crescent shaped. In each band the teeth are arranged in a great many transverse rows, about 300 in number. In the middle part of the band we count 16-30 teeth in one row."

Bean says that the teeth of his Florida specimen are, "— in lower jaw in fourteen longitudinal rows; in upper jaw there are thirteen longitudinal and about three hundred vertical rows of developed teeth." His figure of the upper jaw of the Ormond

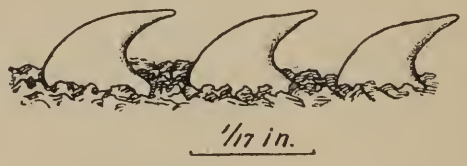

FIG. 131. TEETH OF ORMOND, FLORIDA, SPECIMEN (Enlarged). After Bean (1905).

specimen is given herein as Figure 130, while Figure 131 is a magnified view of three of these teeth.

Last of all Lloyd found the teeth in his specimen to be small, numerous, recurved, in bands in each jaw. Each band had about 350 rows of teeth with about 10 teeth in each row, making approximately 7,000 in all.

Internal Organs.

This shark has been dissected by Smith (1849),[1] by Wright (1870), by Haly (1883) and recently by Van Kampen (1908). Unfortunately, however, none of these authors, save Smith, gives any account of the internal organs. Wright, who had more specimens at his command than any other naturalist, did practically nothing; and the same can be said of Haly and Van Kampen.

[1]Duméril's (1865) excellent account of the internal organs is mainly a translation of Smith's description.

Not so, however, Smith (1849) whose account will now be quoted verbatim.

"Pharynx very large and the inner extremity of each branchial canal obstructed by a sieve-like apparatus, consisting of a conjeries of cartilaginous tubes closely set together, directed laterally, and the inner extremity of each fringed with a delicate membrane offering an obstruction to the passage of anything but fluid. Oesophagus rather narrow, and at its commencement bends downward toward the parietes of the abdomen, and forms nearly a right angle with the fauces, which gives the fish the power of completely preventing what enters its large mouth from being admitted into its stomach, unless desirable. The cardiac extremity of the stomach is very muscular, and the inner surface is studded with hard pointed nipple-like bodies, all of which are directed backward, and offer an obstacle to the return of anything solid from the stomach: the rest of the inner surface of the stomach and the small intestines closely set with strong rugæ, in the stomach oblique, in the intestines nearly circular; and the latter, when about to terminate in the large intestines is also furnished with a number of nipple-like bodies, which prevent solids from passing downward. The termination of the small intestine is in the form of a ring which projects into the large bowel and forms an effective valve when any attempt is made to propel the contents of the large intestine backwards into the smaller. The inner surface of the former is furnished as in other sharks with a spiral band, the one side of which is loose, and by this arrangement the alimentary fluid requires to pass over an extent of surface sufficient to permit of the necessary absorption of the nutritive portion of the ingesta. The rectum, internally, is quite smooth, and the gland which, in sharks generally, is situated behind it, also exists in this fish, and opens into the gut about six inches from the anus. On each side of the latter there is a large opening, through which a probe can be readily introduced into the cavity of the peritoneum, and into that cavity, it would appear, the sea water enters through these openings, as it contained about eight gallons perfectly pure, or at least only with some animal secretions.

"The liver consists of two lobes nearly of equal size, the length of each 3½ feet; the greatest width 13 inches, the least

6 inches. The gall-bladder is exterior to the surface of the liver, and is situated on its concave or dorsal aspect, close to its base, before it divides into lobes. It is of a piriform shape, and the duct is much convoluted and so large as readily to admit the forefinger of a full-grown man; it discharges the bile into the upper extremity of the large intestines, and the point where it enters their outer coat is fully two inches higher than that at which it perforates the inner; the duct between these two points is contracted and tortuous, and the terminal opening is not larger than would admit a pea.

"The spleen is closely connected with the inferior extremity of the stomach and the hinder surface of the small intestine, and, excepting where it winds under the apex of the former, is lobulate, as in the true sharks, and exhibits a striking resemblance to the spleen of *Alopias vulpes,* Raf. The pancreas is slender, and partially encircles the upper extremity of the large intestine."

Food and Feeding.

When one sees or hears the word "shark," one instinctively thinks of a cold-blooded marauder of the seas, with a mouth filled with many rows of sharp, triangular teeth, with a voracious and almost insatiable appetite; a fish, in fact, not averse to human flesh, and with an active habit of life sufficient for the satisfying of such an appetite; in short, all the characters, real or imaginary, summed up in the great man-eater, *Carcharodon rondeletii.*

And yet here we are dealing with the veritable giant of sharks —the Whale Shark, *Rhineodon typus,* whose measured length runs from fourteen to forty-five feet, and whose length estimated by men accustomed to such reckonings may reach the vast figure of seventy feet, but whose manner of life is even more peaceful than that of the common dog-fish. For, be it known, that this largest among fishes is not merely a whale in size, but in manner of feeding, its almost microscopic teeth being in consonance with the minute size of the animals on which it feeds.

Smith, in his first paper, (1829), gives no intimation of the food of this great fish, but in his later (1849) and fuller paper he goes into the matter at length. Since he is the first and only

author to give a complete description of the alimentary organs he has been quoted in full in the preceding section. We will now see what he has to say as to the food of his shark and the manner in which it is obtained.

"The stomach was empty, hence the precise food of the fish could not be ascertained. That a portion of it, at least, is derived from the mollusca, &c., which are taken into the mouth and pharynx, with the sea water which is required for the purifying of the blood, is to be inferred from the branchial openings being so guarded. That the fringes at the inner extremity of the tubes, which exist in the branchial canals, are for the purpose of intercepting such small animals as may be contained in the water, I infer from knowing that the whale (Balæna), which feeds on small mollusca, &c., has the inner edge of each layer of whale bone converted into a fine floating fringe, which permits the water taken into its huge mouth to escape, but intercepts all objects adapted for its food.

"When our shark proceeds to feed, the first step it probably takes is to open its jaws to their full extent, in order to permit the mouth and pharynx to become filled with sea water. On that being accomplished, the jaws are then probably closed in order that the water shall, by muscular efforts in the pharynx, be propelled through the tubes in the branchiæ, and forced thus to leave behind it whatever mollusca, &c., it may chance to contain. The powers of deglutition after this are probably called into action, and the oesophagus, no doubt, is raised and straightened, so as to offer a ready passage downwards to whatever shall have been collected during the escape of the water. The mammillary eminences around the cardiac orifice of the stomach appear to indicate that some, at least, of the articles of food are swallowed alive, and that they require to be bruised and also prevented from re-entering the oesophagus, both of which are probably effected by the processes just mentioned. The direction taken by the upper part of the oesophagus is evidently for the purpose of enabling it the more effectively to resist the entrance of the water, when being expelled through the branchiæ by the muscular contraction of the pharynx."

The man of all others who has had the greatest opportunity to study the feeding and other habits, and who was guilty of

the greatest error, was E. Perceval Wright. While at the Seychelles, just prior to 1870, he dissected at least two specimens, male and female, and wrote that he was able "to preserve all the more important parts of each for more careful examination in Dublin." That he ever did so, however, I have been unable to ascertain. As to its food, here is what he says (1870): "——contrary to the general habits of the true sharks, it is not a carnivorous but a herbivorous fish." However, Steenstrup (1873),[1] having conclusively proved that the great Basking Shark, *Selache* (*Cetorhinus*) *maximus*, which had been thought to feed on algæ, is by virtue of its curious gill apparatus a feeder on small marine organisms, severely criticized Wright's theory of herbivorous feeding in *Rhineodon*. Wright, having satisfied himself by study of *Selache*, that this animal is a carnivore, in 1876 acknowledged his error in these words: "——I now have no doubt that both these big lubberly beasts—which in their mouths have scarcely more than the name of teeth—feed on all sorts of minute oceanic creatures, frequently taking in with them floating algæ.'

Again in 1877, Wright says, and repeats the statement in his *Animal Life* (1879):

"I found large masses of algæ in their stomach, so that at one time I was inclined to think it was an herbivorous shark, probably, however, it derives its nourishment, in part, at least, from minute crustaceans and other oceanic animal forms, which may be taken in along with masses of floating weed, and, then ejecting the water through the strange mesh-like structures that unite the edges of the great gill openings, obtain by so doing enough to swallow."

Günther (1880) writes: "——It has been stated to feed on tang, an observation which requires confirmation." Who the author of this observation is, I have been unable to ascertain. In 1884 Günther, seemingly in ignorance of Steenstrup's and Wright's discussion, cast strong doubt on the herbivorous feeding of the Seychelles fish. Haly (1883) merely notes that "the stomach contained a quantity of finely divided red matter." This was probably crustacean remains. While Gill (1905) clearly

[1]Both Gill (1902) and Bean (1905) erroneously attribute this reference to Lutken.

shows that its food consists of the plankton strained out of the water by its peculiar gill apparatus.

In the stomach of Kishinouye's Japanese specimen (1901), there was found a sucking fish and a fragment of an oak pole one foot in length. A number of sucking-fish were found adhering to the shark when it was caught. Chierchia reports that several were adhering to the inside of the mouth of his specimen.

Van Kampen dissected a fair-sized specimen at Batavia, Java, and reports as follows: "In its stomach I found nothing save some sepia shells, and some small fish (*Gobies, Sauries*)."

Habits.

Offensive Habits.

The Whale Shark, which is in size the chiefest of the Selachians, has absolutely no offensive habits. Its huge bulk may inspire terror, but it is the quietest and most inoffensive of marine animals. The nearest approach to offensive habits is indicated by Wright, who says that: "——it now and then rubs itself against a large pirogue as a consequence upsetting it, but, under such circumstances, it never attacks or molests the men, and while it reigns as a monster among sharks, is not, spite its size, as formidable as the common dog-fish." This action, it may be conjectured, arises either from playfulness or from a desire to rid itself of barnacles or other marine growths.

Defensive Habits.

In such habits, *Rhineodon* seems likewise to be entirely lacking. Smith, its discoverer, says that: "When approached it manifested no great degree of fear, and it was not before a harpoon was lodged in its body that it altered its course and quickened its pace." Dr. Buist says that when harpooned at Kurrachee it is allowed to tire itself out, is pulled in, stunned with clubs and then dragged into shoal water. Chierchia's specimen when struck ran first in circles and then straight away for three hours at a velocity of more than two miles per hour, trying to escape but offering no violence whatever.

Mr. Brooks, in his letter quoted above, notes that the second Florida specimen, at whose capture he was present, did not seem

to be frightened at the approach of the boats, made no resistance when harpooned, when shot, or when pulled to the surface, swam continually in circles, and despite everything done to kill it "seemed to fail to recognize that anything in particular was happening to him."

Beyond seeking to escape by slowly swimming away, this gigantic elasmobranch rarely makes any defense. The only naturalist who tells us anything to the contrary is Wright. He says (1876): "Men engaged at the sperm-whale fishery off St. Denis often told me they dreaded to harpoon by mistake a *Rhinodon.* A whale must come up to breathe or else choke itself. But there were stories told me of how a harpooned *Rhinodon,* having by a lightning-like dive, exhausted the supply of rope which had been accidentally fastened to the boat, dived deeper still, and so pulled the pirogue and crew to the bottom—where, in spite of the harpoon in its neck and its attendant encumbrances, it was at home for a great length of time." And Dr. H. M. Smith (1909), in his interesting paper "Some Giant Fish of the Seas," has a spirited picture showing the fish making the dive.

However, Dr. Gill (1902) seems to doubt this report, which it will be noted is hearsay evidence only, and to the present writer, after a careful study of all the known literature of *Rhineodon,* it seems that Wright has probably been misled. Even when taken in nets (Haly, Kishinouye) there is no evidence that it makes any serious defence. Undoubtedly, *Rhineodon typus* is the mildest mannered shark that swims the seas.

Breeding Habits.

Of such habits there is unfortunately no record of any observation whatsoever. Smith's specimen (so we are informed by Müller and Henle) was a male, but in neither of his papers (1829 and 1849) does he refer to its reproductive organs. Wright and Haly have both dissected females, and the latter expressly says that he was (vainly) hoping to find eggs or embryos, but neither gives any information whatsoever about the organs of generation. The second Florida specimen seems to have been a male, but unfortunately it was not dissected by any scientific person. Probably the Whale Shark is viviparous.

Mounted Specimens.

So far as can be found, the preserved specimens of *Rhineodon typus* in the museums of the world are as follows: (1), Smith's original specimen, preserved by J. Verreaux and now in the Museum of Paris; (2), the one mounted in 1883 in the Colombo Museum under the direction of A. Haly; (3), the one in the British Museum (Haly's second specimen) mounted by Gerrard about 1890; (4), the Madras specimen of 1889, presumably mounted under the direction of Thurston; (5), the Japanese specimen (1901) preserved by a local curio dealer in Tokyo; (6), the first Florida specimen (1902), the skin of which is preserved in the United States National Museum; (7), Capt. Thompson's specimen from Florida, now on exhibition in the various cities of the United States.

Name.

At first (1829) Smith gave his great shark the name *Rhincodon typus,* but later (1849) changed it to the more common forms *Rhinodon typicus.* The reason for this will now be given.

In 1831 Bonaparte followed Smith in using the generic name *Rhincodon.* In 1838-1839 Swainson published the names *Rineodon, Rhineodon* and *Rhiniodon.* About the same time Müller and Henle, at the conclusion of their visit to London made to collect data for their great forthcoming work on Selachians, published in the *Magazine of Natural History* and in *Archiv für Naturgeschichte* (1838) a preliminary paper in which they give the genus *Rhineodon,* but three years later (1841), when they published their great work on sharks and rays entitled *Systematische Beschreibung der Plagiostomen,* they gave this shark the name *Rhinodon typicus,* which has been the one commonly used ever since. Careful scrutiny of their work reveals no reason whatever for this change. However, when Smith (1849) came to give his larger and more complete description of the Whale Shark, he gave up the name he had first used and adopted the last one propounded by Müller and Henle.

Dr. Gill in 1902 used the name *Rhinodon typicus,* but noted that *Rhineodon* was the first generic title. In his second paper, however, this great ichthyologist returns to the correct name

Rhineodon typus, which in accordance with the rules of priority must be used. But why not *Rhincodon,* may be asked. It is true that the printer in England mistook Smith's "e" for a "c," and Smith being at the Cape of Good Hope, this error was uncorrected. But since the derivation is *rhine,* file + *odous* (odont) tooth, it would be absurd to let the error stand, and hence the present writer has used what seems to him the correct terminology, *Rhineodon typus.*

Since the above went to press I have found the following statement by Günther (1910): "The name in this publication [*Zool. Jour.* XVI. 1829] is *Rhincodon;* this appears, however, to have been a typographical error, at least the original drawing, which is in my possession, is labelled in Smith's own hand *Rhinodon typicus.*" This, however, does not negative the above conclusions, since this finished drawing, first published in 1849, was presumably not made until some time, possibly long time, after 1829, and in the name Smith simply followed Müller and Henle (1841).

Note:—Dr. David Starr Jordan, in *Science* for March 26, 1915 (page 463), records the receipt from Mr. W. F. Cameron, a correspondent of his at Zamboanga, Philippine Islands, of a photograph of a 20-foot specimen of the Whale Shark, taken at the Island of Zebu. In its stomach were found a number of shoes, leggings, leather belts, etc., a most incongruous mass of stuff in reference to what we know of the feeding habits of this great shark. This adds another to our short list of specimens, and the second for the Philippines. E. W. G.

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